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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

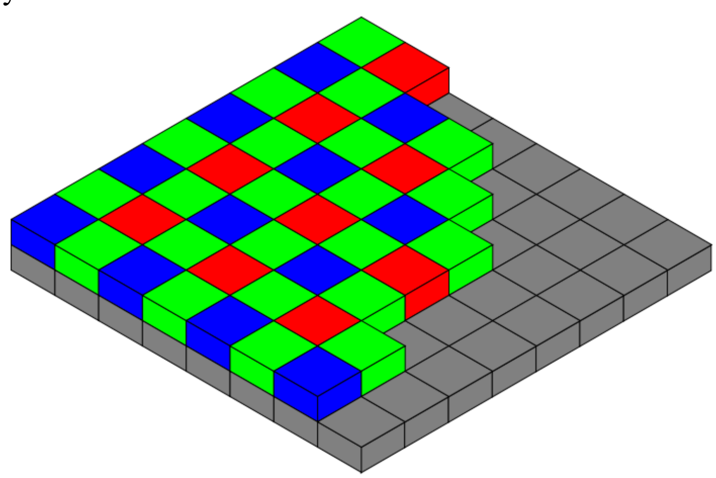
COREPHOTONICS, LTD., Plaintiff, v. APPLE INC., Defendant.	Case No. 3:17-cv-06457-JD (lead case) Case No. 5:18-cv-02555-JD **APPLE INC.'S TECHNOLOGY SYNOPSIS** Date: February 7, 2022 Time: 2:00 PM Courtroom: 11 Before: Hon. James Donato

Pursuant to Paragraph 8 of the Court's Standing Order for Claim Construction in Patent Cases before Judge James Donato, Defendant Apple Inc. ("Apple") respectfully submits this written technology synopsis in advance of the tutorial scheduled for February 7, 2023 at 2:00 p.m.

The two patents asserted in this case generally relate to cameras, including digital cameras. In order to create a photograph, the lens in a camera captures light and casts it onto a photo-sensitive recording medium. Traditionally, the photo-sensitive recording medium was analog film. Today, the photo-sensitive recording medium in digital cameras is an electronic image sensor. The film or sensor is generally located within the camera body at a location referred to as the **image plane**, which is the plane where incoming light is focused, allowing the film or sensor to capture a properly focused image.

An electronic image sensor converts incoming light (photons) into an electrical signal that can be viewed, analyzed, or stored. An image sensor is divided into a grid of millions of photosensitive sites (also called photosites). Each photosite makes up a portion of the picture, which is also known as a picture element, or pixel. Each photosite measures the intensity of the light rays coming from the corresponding portion of the scene.

The photosites on an image sensor do not themselves measure color information. Therefore, in a color camera, a grid of color filters is placed over the sensor. The filter allows only certain wavelengths of light to pass and absorbs the remaining wavelengths. An exemplary type of pattern filter is shown below, which exposes each pixel site to either red, green, or blue. Each photosite measures the intensity of the color that reaches it.



After exposure, each photosite generates a value of the light intensity that reaches it. The

intensity value at each photosite corresponds to the light intensity of the color filter placed above that photosite. For example, each photosite in a sensor using the above mosaic generates intensity value for red, green, or blue. The received light intensity values at the photosites are converted into digital signals in an analog-to-digital converter.

Because the raw data from this type of sensor has just one value for each pixel corresponding to only one color (red, green, or blue), a later digital signal process (called "demosaicing") is used to reconstruct a full color image using the raw data coming from the image sensor. Demosaicing generally uses an algorithm that estimates the missing color components for a given pixel by interpolating values from nearby pixels.

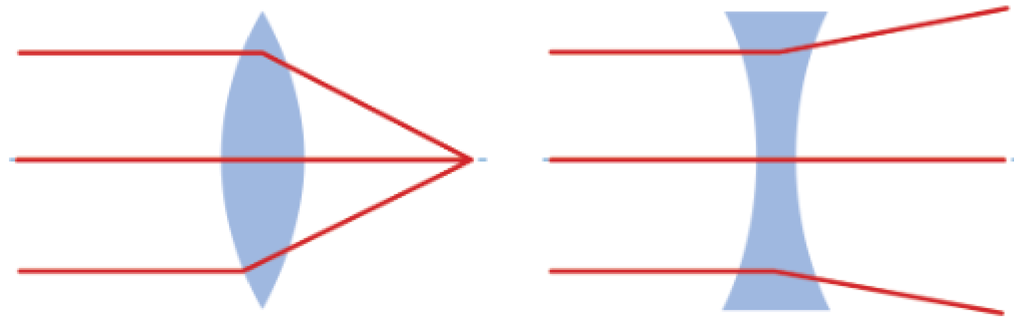
The collection of each of the values for a particular color for all of the pixels is commonly referred to as a color channel. For example, an RGB color image has red, green, and blue color channels.

A **lens** is made of glass, plastic, or other transparent material that concentrates or diverges light that passes through it. In a camera, a lens is placed in front of the film or image sensor so that light from the subject or scene passes through the lens and is focused onto the film or image sensor, creating an image.

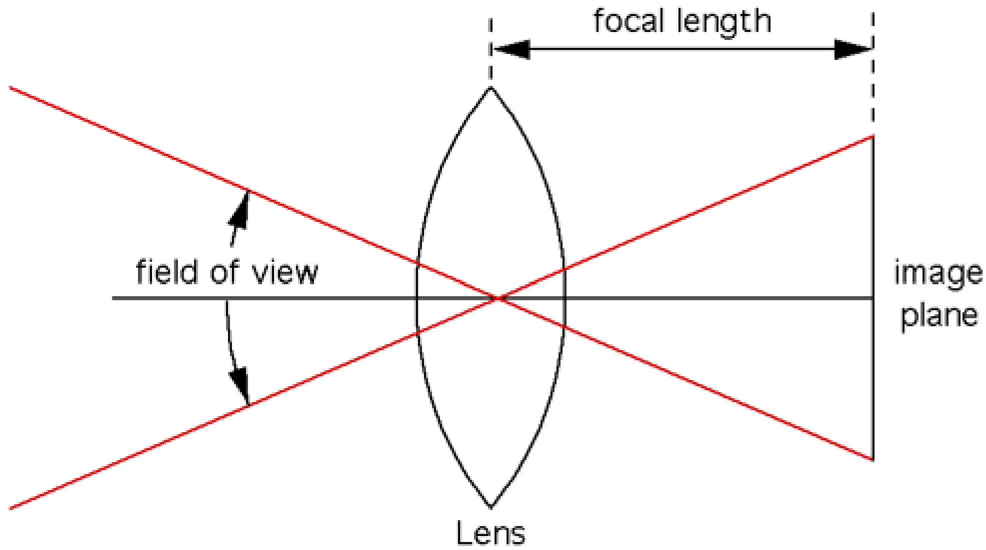
Camera lenses may contain one lens element or multiple **lens elements**. Current photographic lenses have multiple lens elements. Increasing the number of lens elements generally provides increased ability to correct for image defects known as optical aberrations and increased flexibility in determining the overall lens size.

Lens elements may be either **positive** or **negative**. A positive lens element converges incoming light rays, as shown below to the left. Similarly, a negative lens element diverges incoming light rays, as shown below to the right.[1]

[1] Images from https://www.opto-e.com/en/basics/optics.

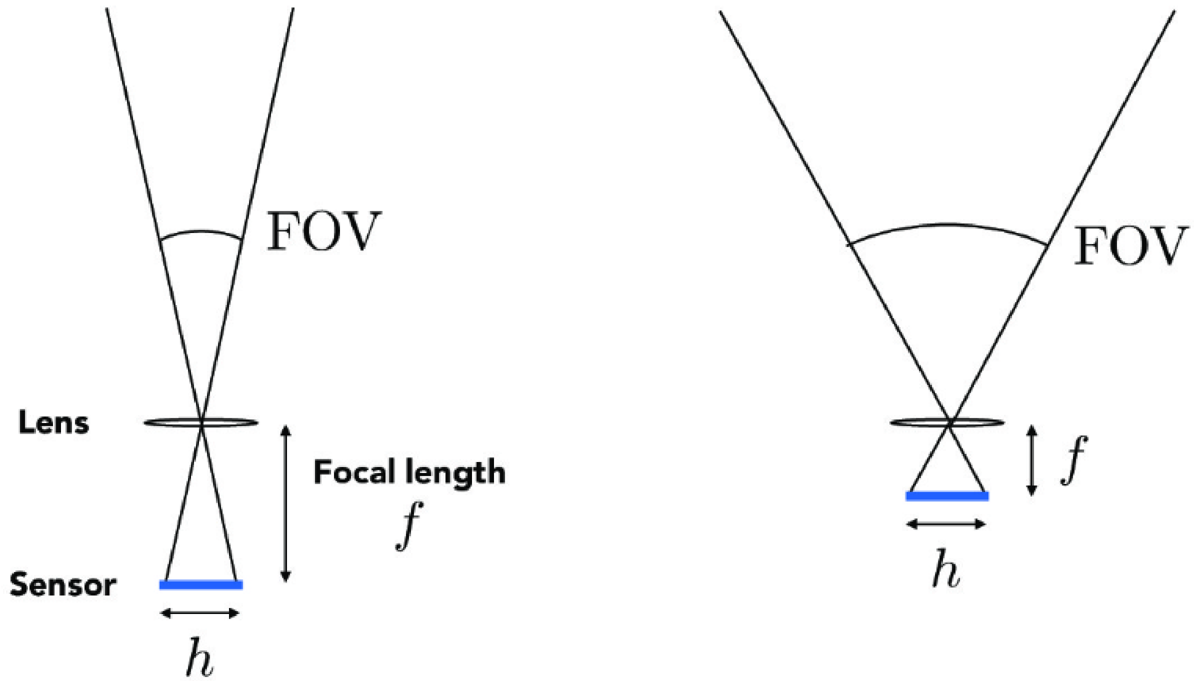


The concept of "focal length" refers to the distance between a lens and the image plane when the subject is in focus. For a lens with a single lens element, the focal length is the distance between the rear nodal point of that lens element and the focal/image plane, as illustrated here:[2]



Focal length is a differentiator between types of lenses because – for a given film or sensor – the focal length determines the field of view, which relates directly with the amount of a scene that is captured onto the film or sensor of a given size. A longer focal length corresponds with a narrower field of view, as shown to the left below. A shorter focal length corresponds with a wider field of view, as shown to the right below.[3]

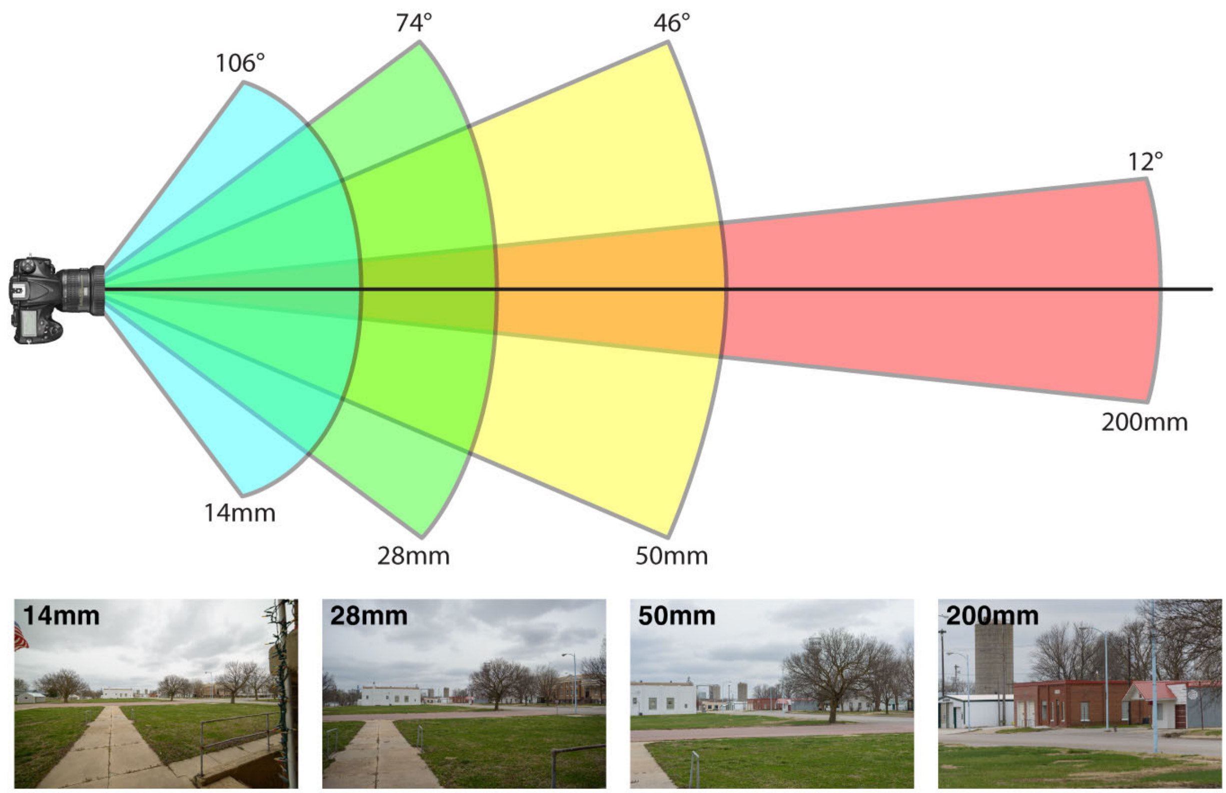
[2] Image from http://paulbourke.net/miscellaneous/lens/.
[3] Image from https://cs184.eecs.berkeley.edu/sp19/lecture/15-10/cameras-and-lenses.



A standard or normal lens generally has a field of view that roughly approximates the perspective of human vision, which is approximately 50 degrees. This is also approximately the field of view of a camera using 35mm film, commonly known as a 35mm camera. A "**wide-angle**" lens (which will have a short focal length as shown above) has a field of view that is substantially broader than 50-degrees. For example, a lens with a 90-degree field of view would be considered a wide-angle lens. A long focal length lens has a narrow field of view. For example, a long focal length lens may have a 28-degree field-of-view.

The image below provides an illustration of different focal lengths, their respective fields-of-view, and an example image of the same scene captured at each different focal length.[4]

[4] Image adapted from http://www.thedigitalprocess.com/learn-about-camera-lenses-a-guide/.



In the example above, all of the images are taken from the same position and direction, which is called the camera's **point-of-view**. A camera may have multiple apertures (openings), each with a different lens. Because the apertures are not in the same location, the two lenses will necessarily have differing points-of-view. The different lenses may also have different fields of view. As an illustration, the following image depicts a cell phone camera with multiple apertures which have different lenses, specifically, wide-angle lens 612 and telephoto lens 616:[5]

[5] Image from U.S. Pat. Pub. No. 2008/0030592 to Border et al. (Dkt. 150-2), which is discussed in the Background section of asserted U.S. Patent No. 9,185,291 at col. 2:1-24.

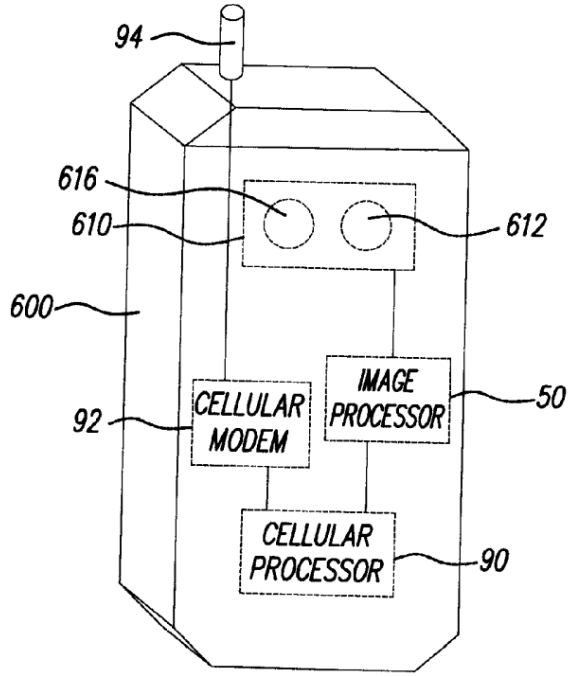


FIG. 3B

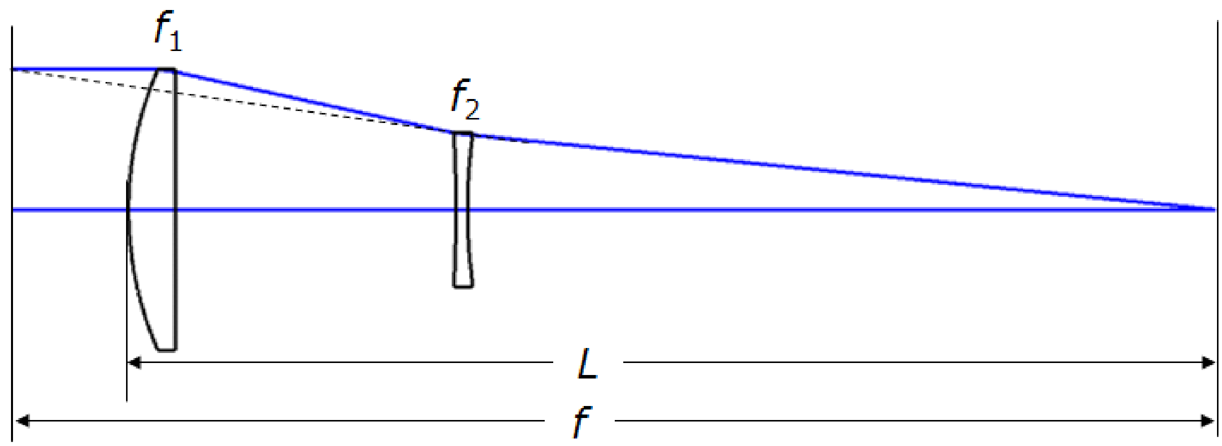
For lenses with multiple lens elements, the concept of **effective focal length** or "**EFL**" measures the distance from the lens to the image plane.[6] The distance from the outermost surface of the lens to the image plane in the camera body is referred to as **total track length**, or "**TTL**."[7]

In the 19th century, the invention of a lens combination technically known as a **telephoto** lens allowed for the construction of compact, long focus lenses. A telephoto lens generally has at least one converging (positive) lens in front of at least one diverging (negative) lens. This combination of the positive and negative lenses allows for an effective focal length (EFL or f) that is longer than the total track length (TTL or L), as shown here:[8]

[6] The parties in this case agree that the claim term "effective focal length (EFL)" means "the focal length of a lens assembly." (Dkt. 147 at 1.)

[7] The parties in this case agree that the claim term "total track length (TTL)" means "the length of the optical axis spacing between the object-side surface of the first lens element and one of: an electronic sensor, film, and an image plane corresponding to either the electronic sensor or a film sensor." (Dkt. 147 at 1.)

[8] Image from https://www.pencilofrays.com/lens-design-forms/#telephoto.



The effective focal length (EFL) of a telephoto lens may be understood with the concept of a single virtual lens that produces the same image as the telephoto lens, as shown here:[9]

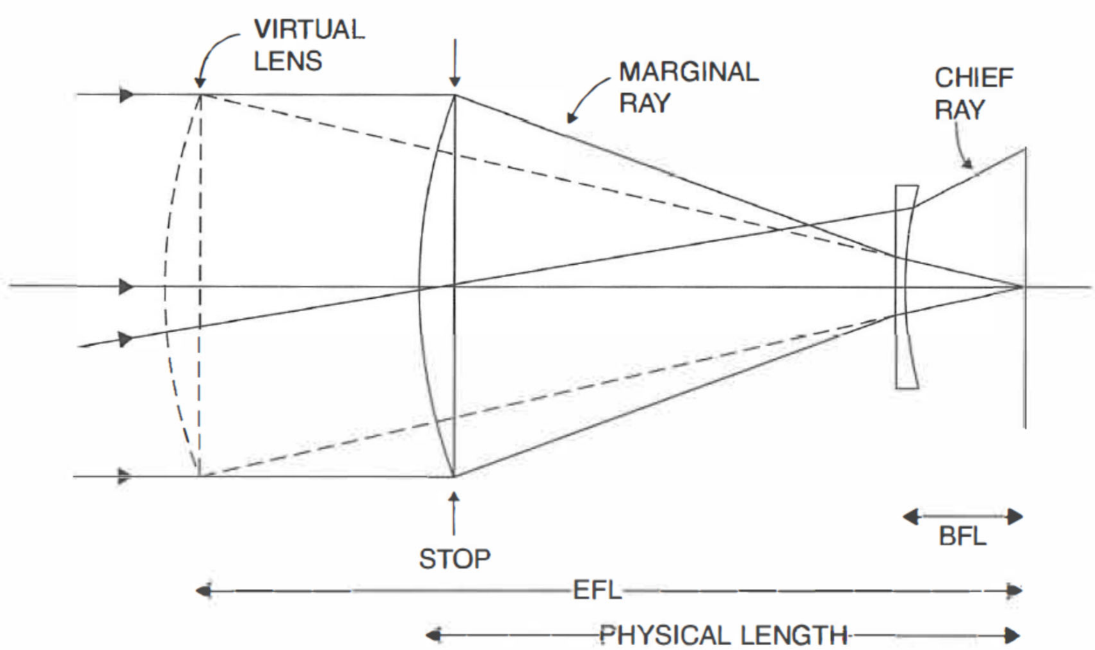


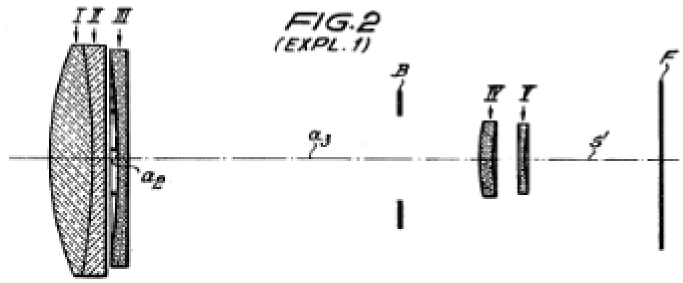
Figure 8.5 Telephoto lens. From *Practical Computer-Aided Lens Design* published by Willmann-Bell, Inc. (www.willbell.com) Used with permission.

The effective focal length (EFL) is the focal length of the virtual single lens as shown above.

Telephoto lenses may have various numbers of lens elements. Increasing the number of lens elements provides more degrees of design freedom to mitigate optical aberrations and achieve the desired image quality. For example, a telephoto lens may have three lens elements in front and two lens elements in back, as shown here in a lens design from U.S. Patent No. 3,388,956, which

[9] Image from Dkt. 150-8 at 59.

issued in 1968:[10]



These five-element designs reflect the original telephoto concept of having a positive lens in front and a negative lens in back. The front positive portion is split into three elements that together still have an overall positive power, and the back negative portion is split into two elements that together still have overall negative power.

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[10] Image from U.S. Patent No. 3,388,956, at Figure 2.